FIG. 1A

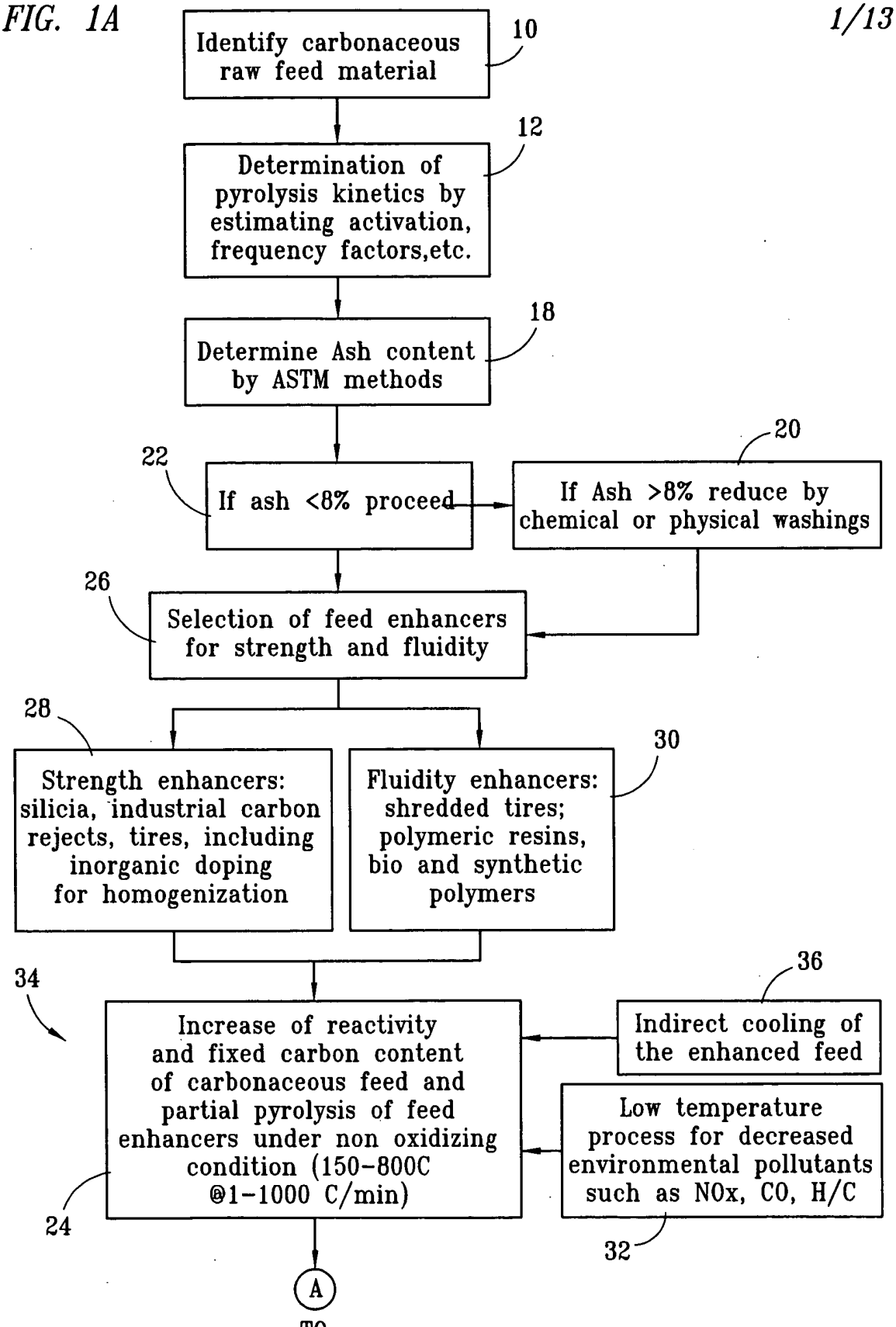

Identify carbonaceous raw feed material
10
Determination of pyrolysis kinetics by estimating activation, frequency factors,etc.
12
Determine Ash content by ASTM methods
18
22
If ash <8% proceed
If Ash >8% reduce by chemical or physical washings
20
26
Selection of feed enhancers for strength and fluidity
28
Strength enhancers: silicia, industrial carbon rejects, tires, including inorganic doping for homogenization
Fluidity enhancers: shredded tires; polymeric resins, bio and synthetic polymers
30
34
Increase of reactivity and fixed carbon content of carbonaceous feed and partial pyrolysis of feed enhancers under non oxidizing condition (150-800C @1-1000 C/min)
24
36
Indirect cooling of the enhanced feed
Low temperature process for decreased environmental pollutants such as NOx, CO, H/C
32
A
TO

FIG. 1B

FIG. 1B

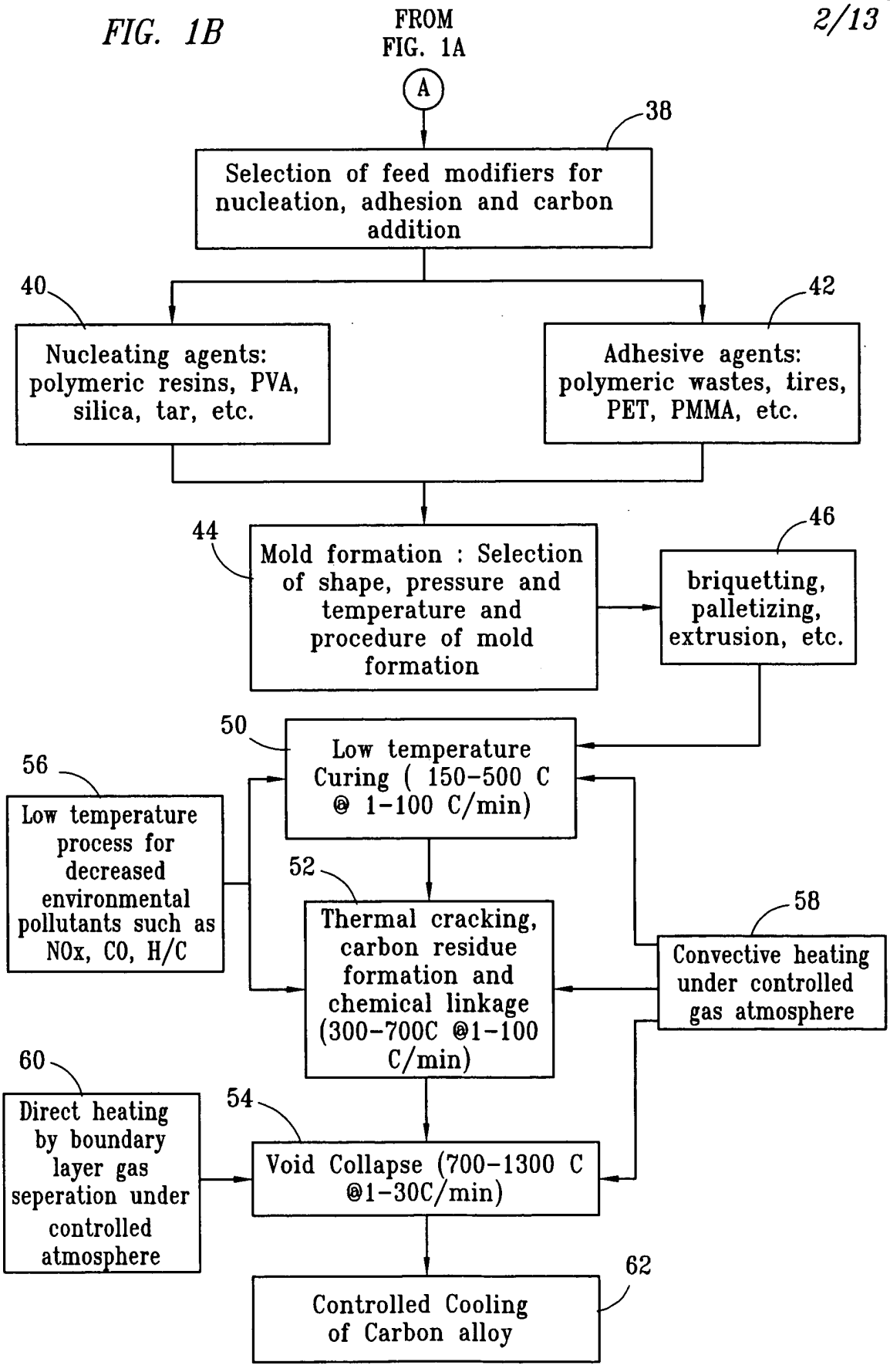
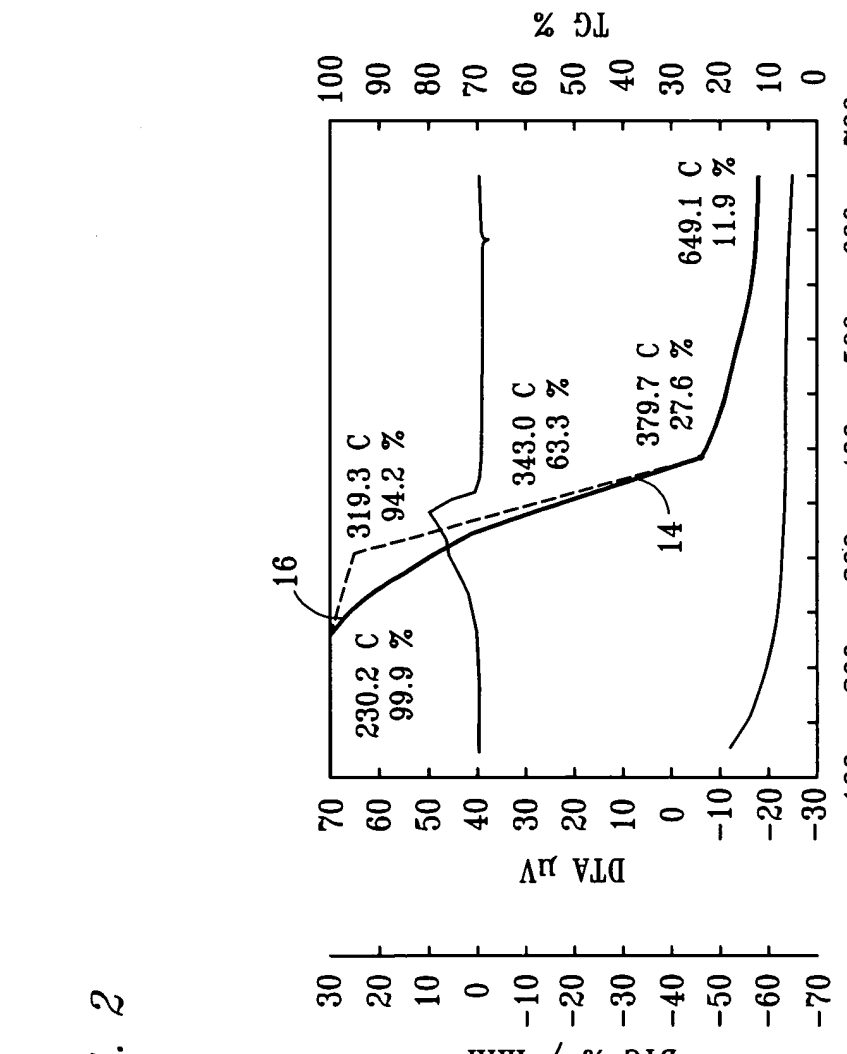

FROM FIG. 1A
A
38
Selection of feed modifiers for nucleation, adhesion and carbon addition
40
Nucleating agents: polymeric resins, PVA, silica, tar, etc.
42
Adhesive agents: polymeric wastes, tires, PET, PMMA, etc.
44
Mold formation : Selection of shape, pressure and temperature and procedure of mold formation
46
briquetting, palletizing, extrusion, etc.
50
Low temperature Curing (150-500 C @ 1-100 C/min)
56
Low temperature process for decreased environmental pollutants such as NOx, CO, H/C
52
Thermal cracking, carbon residue formation and chemical linkage (300-700C @1-100 C/min)
58
Convective heating under controlled gas atmosphere
60
Direct heating by boundary layer gas seperation under controlled atmosphere
54
Void Collapse (700-1300 C @1-30C/min)
62
Controlled Cooling of Carbon alloy

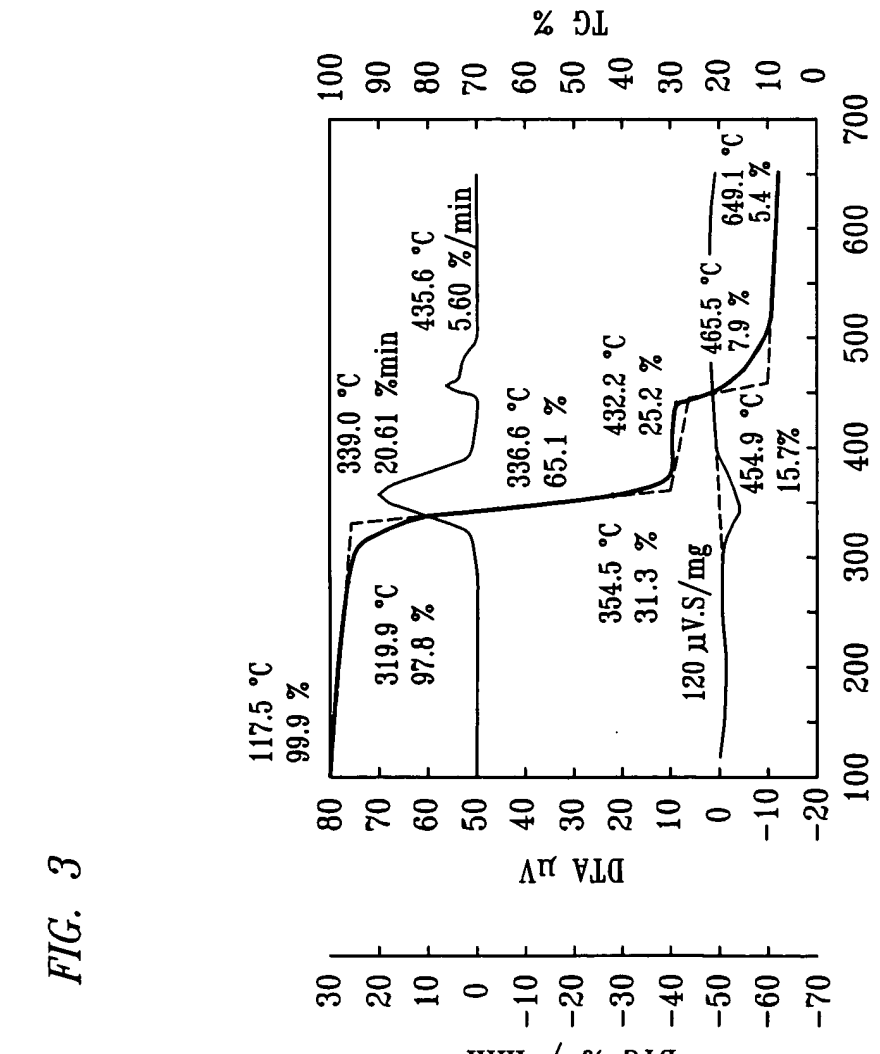
FIG. 2



Eastern red cedar
(Juniperus Virginiana)

Eastern red cedar (Juniperus virginiana)
Heating rate-°C/min: 10
Sample weight-mg: 11.09
T initial-°C: 230.2
Volatilization
T start point-°C: 319.3
T mid point-°C: 343.0
T end point-°C: 379.7
T max-°C: 367.2
Rate max-mg/min: 11.45
Wt. 650 °C -: 11.9
Δ Hvol-μv.sec/mg: NS
Proximate analysis
Volatiles Total -wt%: 93.5
Volatiles 650 °C -wt%: 88.1
Volatiles 650-950 °C -wt%: 5.4
Fixed carbon-wt%: 5.0
Ash-wt%: 1.5

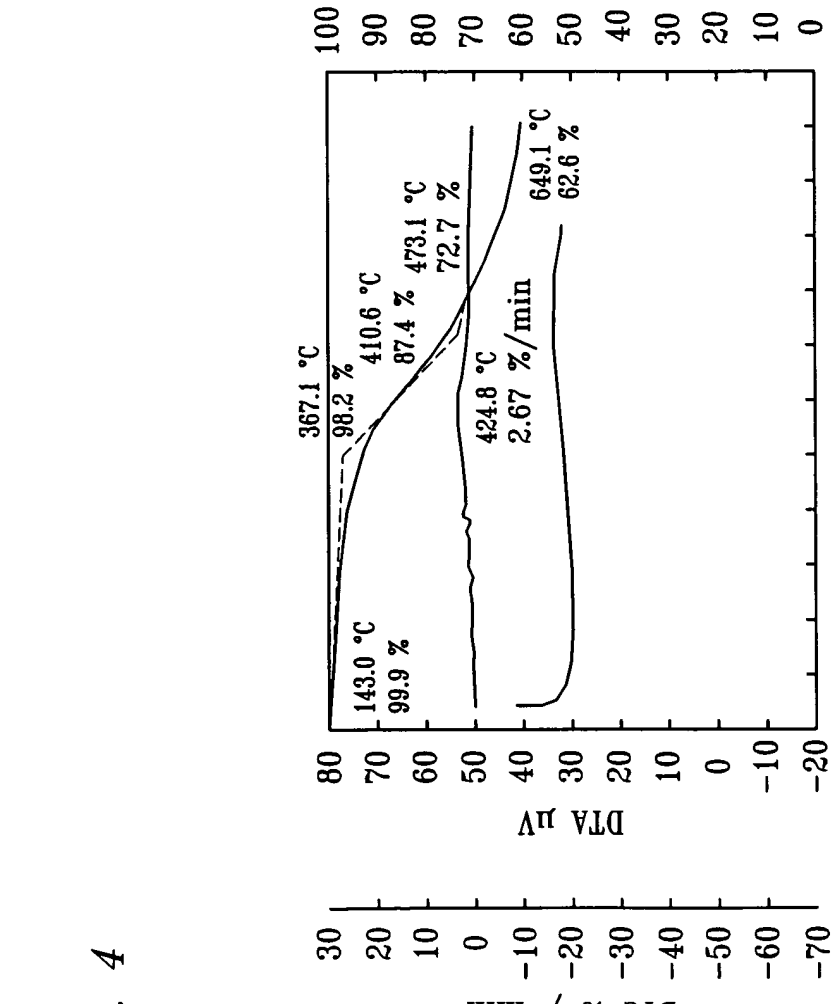
FIG. 3



Polyvinyl acetate

Polyvinyl acetate
Heating rate-°C/min: 10 Sample weight-mg: 2.121 T initial-°C: 117.5
Volatilization T start point-°C: 319.1 T mid point-°C: 336.6 T end point-°C: 354.5 T max-°C: 339.0 Rate max-mg/min: 20.61 Wt. 650 °C -: 5.4 Δ Hvol-μv.sec/mg: 120
Proximate analysis Volatiles Total -wt%: 94.6 Volatiles 650 °C -wt%: 94.6 Volatiles 650-950 °C -wt%: 0.0 Fixed carbon-wt%: 5.4 Ash-wt%: 0.0

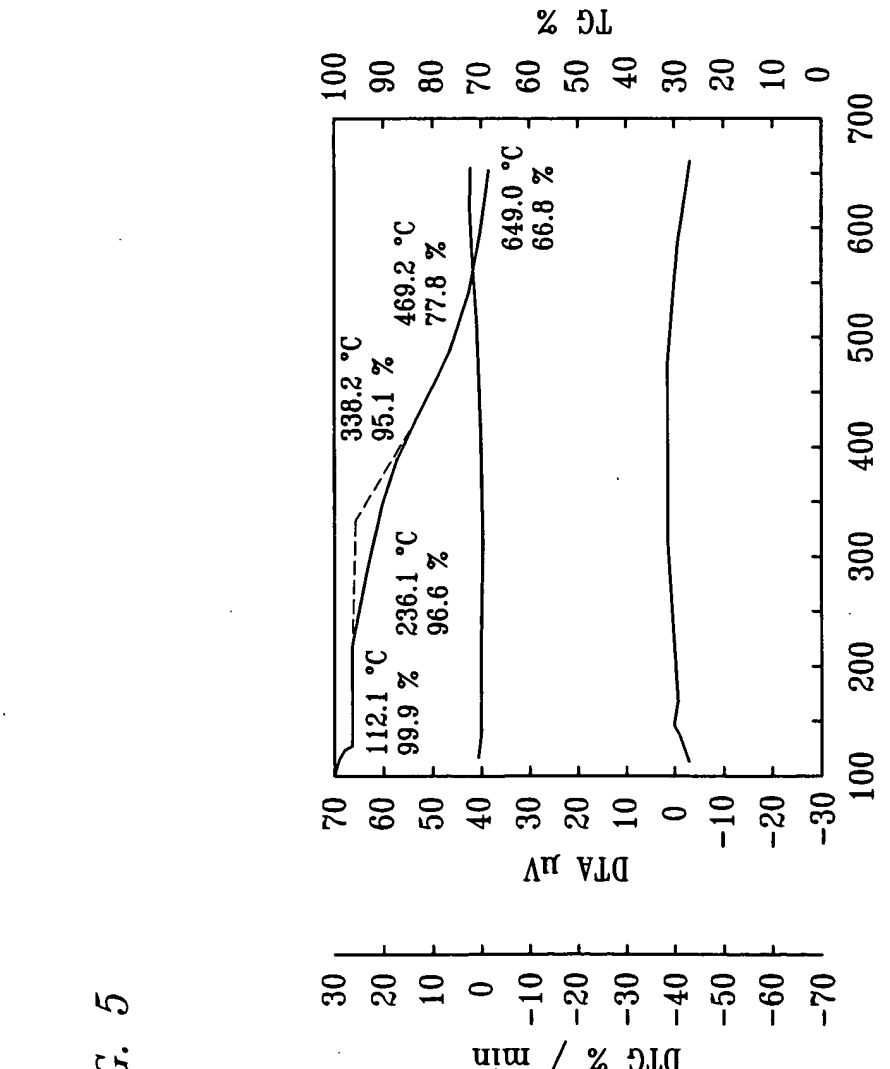
FIG. 4



Coal, Wyodak bituminous
(Subbituminous, Wyoming)

Coal, Wyodak bituminous (Subbituminous, Wyoming)
Heating rate-°C/min: 10
Sample weight-mg: 7.060
T initial-°C: 143.0
Volatilization
T start point-°C: 367.1
T mid point-°C: 410.6
T end point-°C: 473.1
T max-°C: 424.8
Rate max-mg/min: 2.67
Wt. 650 °C -: 62.6
Δ Hvol-μv.sec/mg: NS
Proximate analysis
Volatiles Total -wt%: 55.1
Volatiles 650 °C -wt%: 37.4
Volatiles 650-950 °C -wt%: 17.7
Fixed carbon-wt%: 37.9
Ash-wt%: 7.0

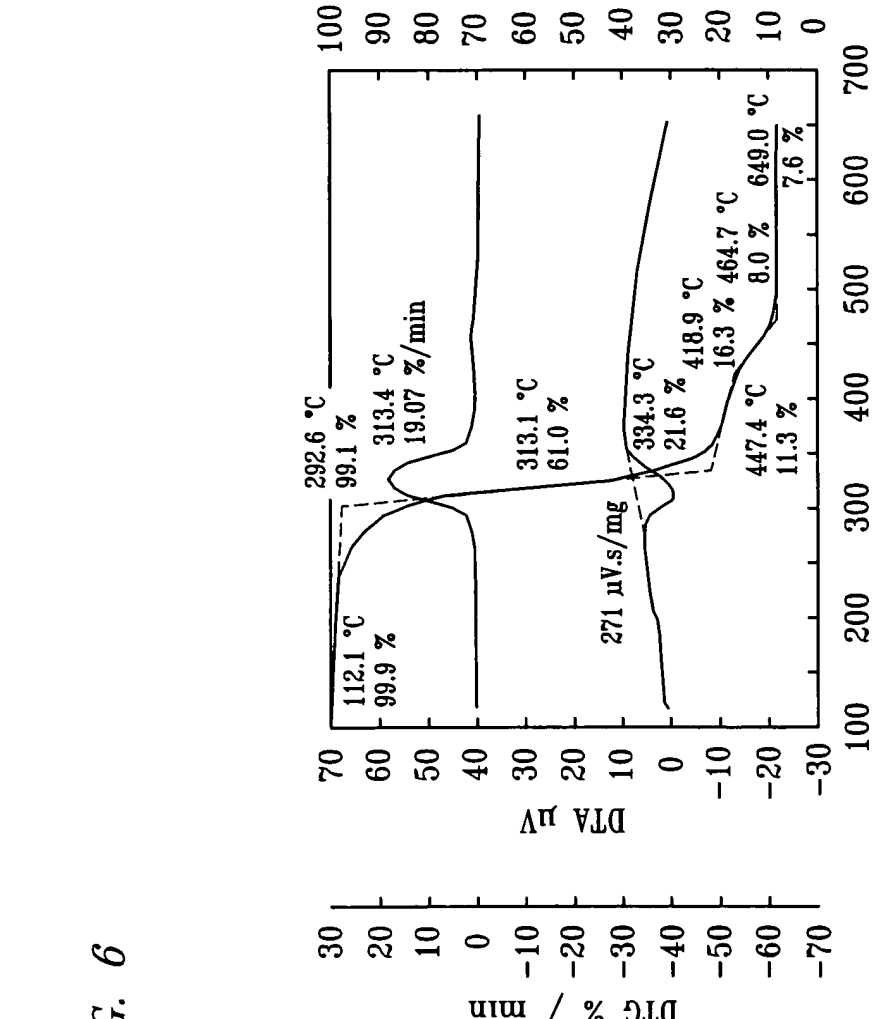
FIG. 5



Coal, Buelah zap lignite
(North Dakota)

Coal, Buelah zap lignite (North Dakota)
Heating rate-°C/min: 10 Sample weight-mg: 6.297 T initial-°C: 112.1
Volatilization T start point-°C: 236.1 T mid point-°C: 338.2 T end point-°C: 469.2 T max-°C: NA Rate max-mg/min: NS Wt. 650 °C -: 66.8 Δ Hvol-μV.sec/mg: NS
Proximate analysis Volatiles Total -wt%: 39.7 Volatiles 650 °C -wt%: 33.2 Volatiles 650-950 °C -wt%: 6.5 Fixed carbon-wt%: 52.1 Ash-wt%: 8.2

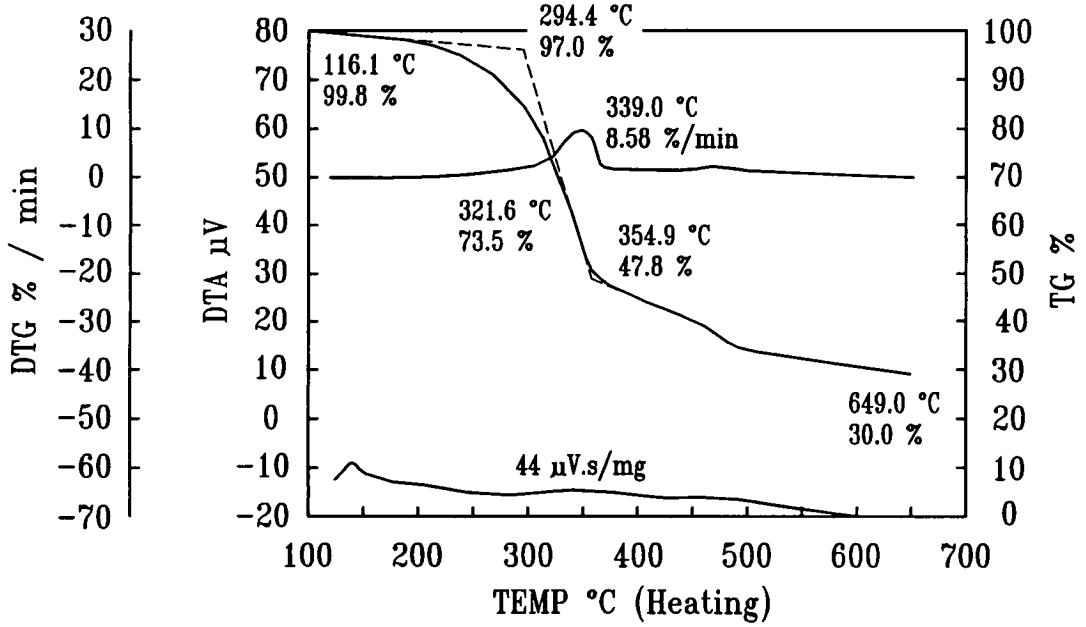
FIG. 6



Paraffin

Paraffin
Heating rate-°C/min: 10 Sample weight-mg: 4.751 T initial-°C: 112.1
Volatilization T start point-°C: 292.6, 418.9 T mid point-°C: 313.1, 447.4 T end point-°C: 334.3, 464.7 T max-°C: 313.4 Rate max-mg/min: 19.07 Wt. 650 °C -: 7.6 Δ Hvol-µv.sec/mg: 271
Proximate analysis Volatiles Total -wt%: 93.0 Volatiles 650 °C -wt%: 92.4 Volatiles 650-950 °C -wt%: 0.6 Fixed carbon-wt%: 5.9 Ash-wt%: 1.1

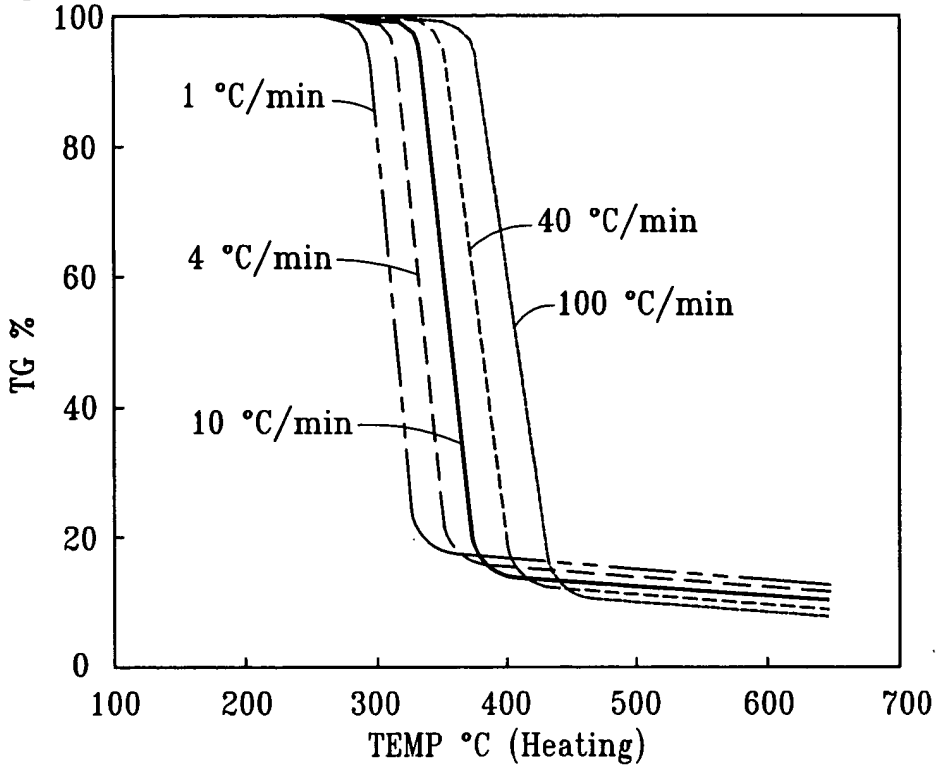
FIG. 7



Refuse-derived fuel
(Teledyne)

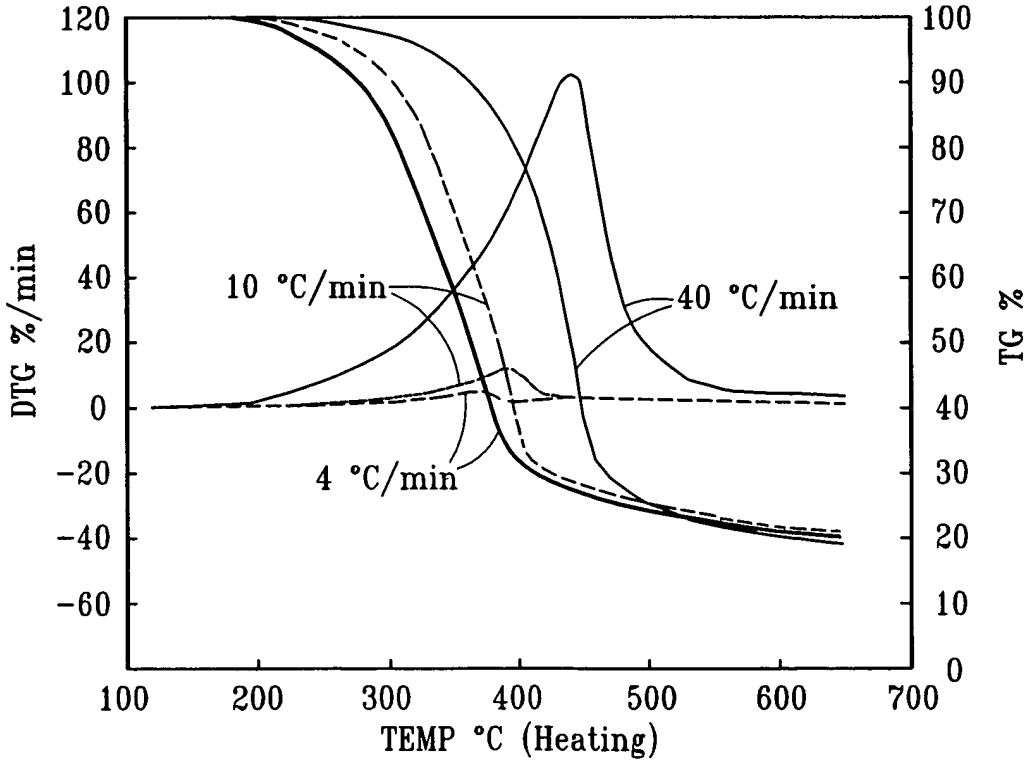
Refuse-derived fuel (Teledyne)
Heating rate-°C/min: 10 Sample weight-mg: 5.245 T initial-°C: 116.1
Volatilization T start point-°C: 294.4 T mid point-°C: 321.6 T end point-°C: 354.9 T max-°C: 339.0 $Rate_{max}$-mg/min: 8.58 Wt. $_{650\ °C}$ -: 30.0 Δ Hvol-µv.sec/mg: 44
Proximate analysis Volatiles $_{Total}$ -wt%: 76.8 Volatiles $_{650\ °C}$ -wt%: 70.0 Volatiles $_{650-950\ °C}$ -wt%: 6.8 Fixed carbon-wt%: 16.4 Ash-wt%: 6.8

FIG. 8



Effect of Heating Rate
(Heated at 1, 4, 10, 40 and 100 °C/min)

FIG. 9



Effect of Heating Rate

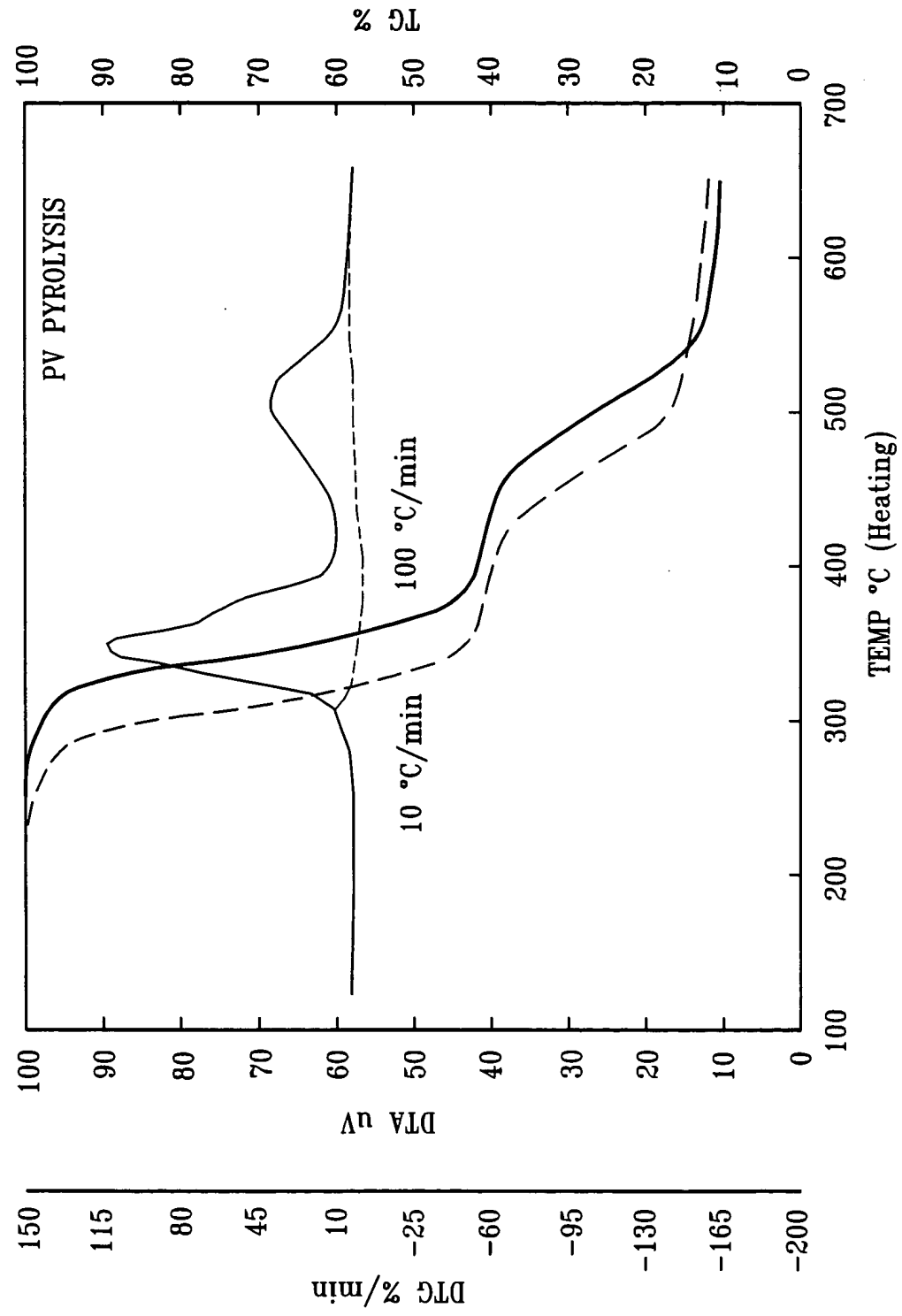

PV PYROLYSIS
100 °C/min
10 °C/min
TEMP °C (Heating)
TG %
DTA uV
DTG %/min
100
90
80
70
60
50
40
30
20
10
0
700
600
500
400
300
200
100
150
115
80
45
10
-25
-60
-95
-130
-165
-200

FIG. 10

FIG. 11

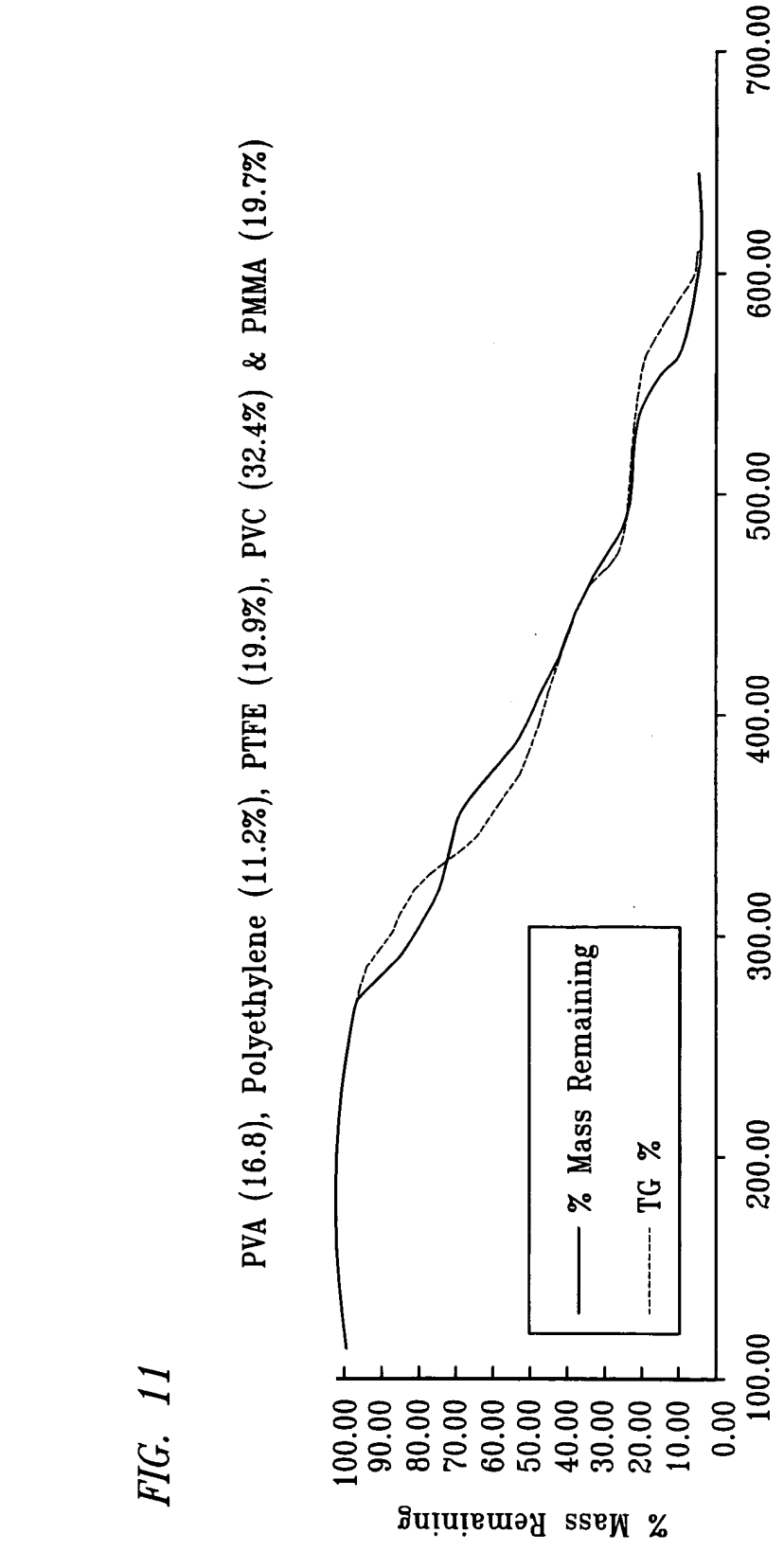
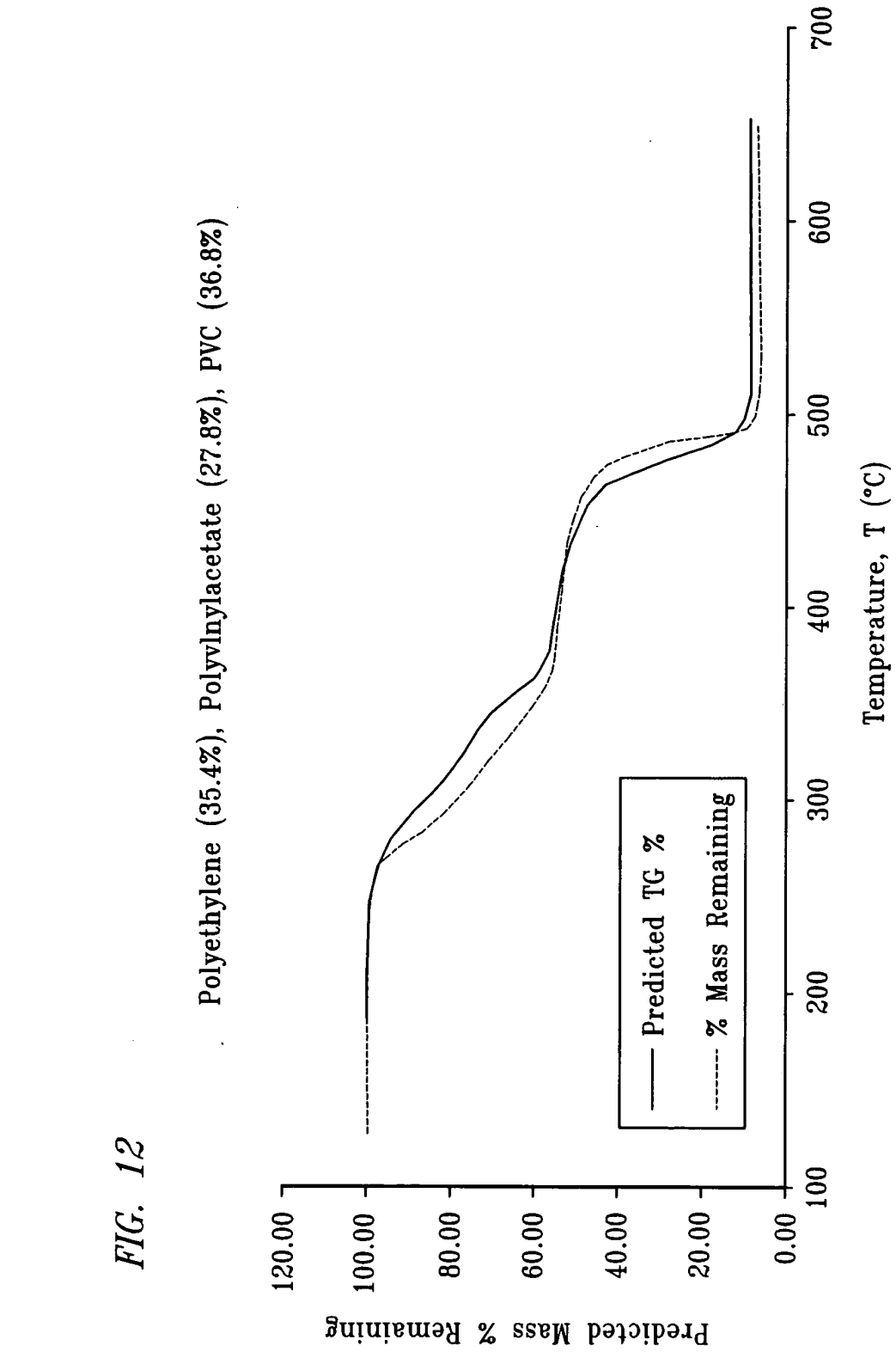

PVA (16.8), Polyethylene (11.2%), PTFE (19.9%), PVC (32.4%) & PMMA (19.7%)
% Mass Remaining
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
100.00
200.00
300.00
400.00
500.00
600.00
700.00
Temperature, T (°C)
% Mass Remaining
TG %

FIG. 12


Polyethylene (35.4%), Polylnylacetate (27.8%), PVC (36.8%)
Predicted Mass % Remaining
120.00
100.00
80.00
60.00
40.00
20.00
0.00
100
200
300
400
500
600
700
Temperature, T (°C)
Predicted TG %
% Mass Remaining

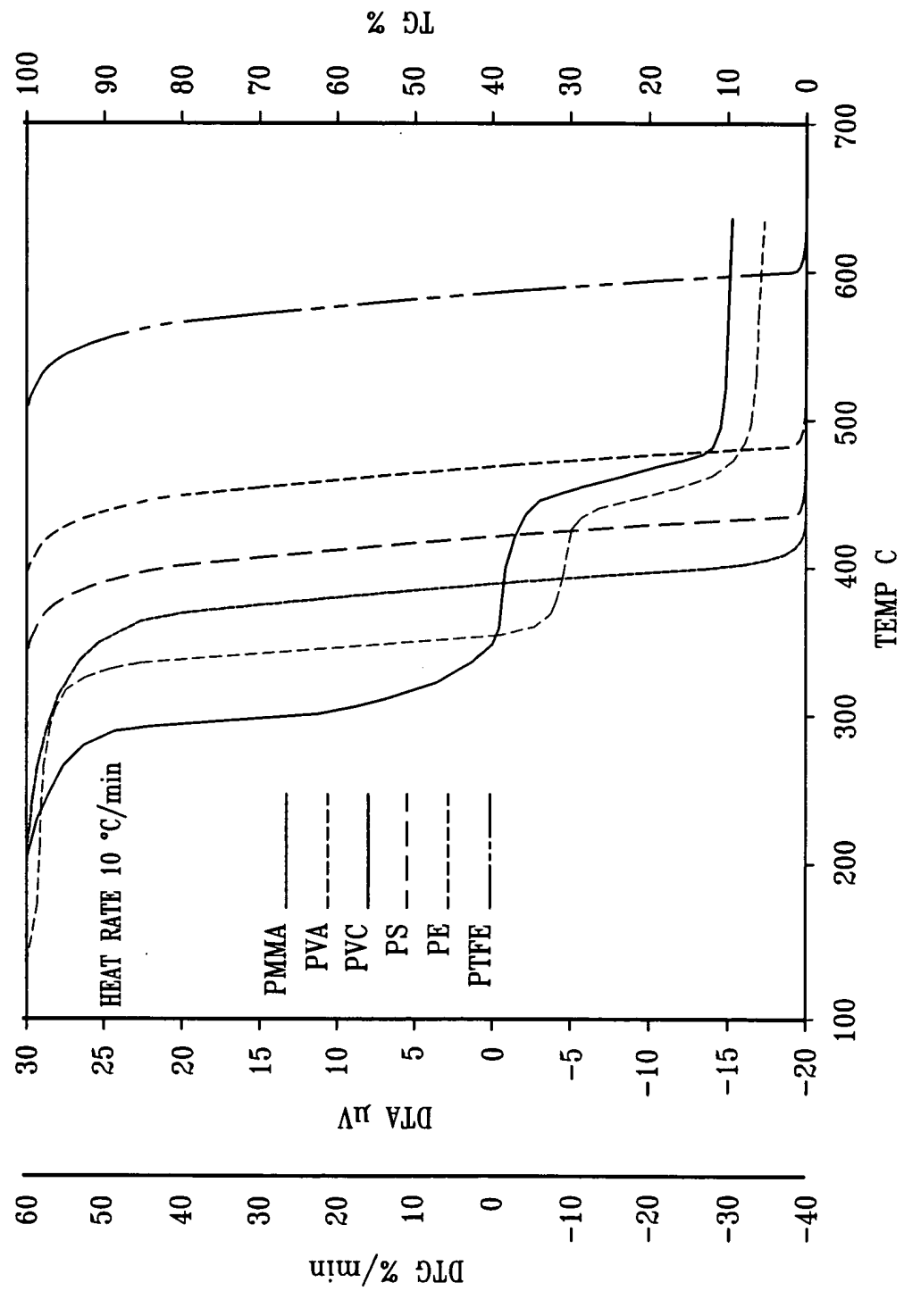

TG %
100
90
80
70
60
50
40
30
20
10
0
700
600
500
400
300
200
100
TEMP C
DTA μV
30
25
20
15
10
5
0
-5
-10
-15
-20
DTG %/min
60
50
40
30
20
10
0
-10
-20
-30
-40
HEAT RATE 10 °C/min
PMMA
PVA
PVC
PS
PE
PTFE

FIG. 13